

FRANK HÄTTICH, *Quantum Processes: A Whiteheadian Interpretation of Quantum Field Theory*, Münster: Agenda Verlag, 2004: 280 pages. [Reviewed by Henry P. Stapp, Lawrence Berkeley Laboratory, University of California, Berkeley]

This book is a “must-read” for philosophers and physicists interested in the problem of constructing an ontology that is compatible with contemporary physics. The apparent suitability of Whitehead’s ideas as a foundation for the development of a *theory of reality* has been noted by many quantum physicists, including Abner Shimony (1993), Rudolf Haag (1996), and myself (Stapp, 1979). The main reasons are, firstly, that Whitehead’s “actual occasions” (or “actual events”) are functionally similar to the “reductions of the wave packet” (or “collapses of wave function”) that play a key role in orthodox contemporary physics; and, secondly, that both Whitehead’s ontology and orthodox quantum theory give these events a *mental* aspect, and make these aspects causally efficacious in the physical world. In orthodox quantum theory this causal efficacy of experiential realities arises from von Neumann’s “Process 1”, which injects effects of conscious choices crucially into the dynamics. Also, Heisenberg (1958), when considering what is *really happening*, speaks of these reduction events as transitions from “possible” to “actual”, in accord with Whitehead’s idea of the function of actual occasions..

Whitehead mentions quantum theory several times in *Process and Reality*, and was clearly aware of, and influenced by, the early phases of the

development of quantum theory (PR, p. 239). But Hättich correctly emphasizes that contemporary basic quantum theory, namely quantum field theory, was developed later and is conceptually much more sophisticated than what is suggested by those early models, particularly as regards the incorporation of the constraints imposed by the Theory of Relativity. The difference, in this regard, between Whitehead's approach and that of Quantum field theory is major, and Hättich claims that the *former* encounters inconsistencies that the latter avoids.

Whitehead introduces the impact of Relativity with the words: "Curiously enough, even at this early stage of metaphysical discussion the influence of the 'relativity theory' of modern physics is important." (PR, p. 65). Whitehead was certainly very familiar with Einstein's theory of relativity. But that theory is a *classical* theory, and is deterministic: the entire history of the universe is laid out. The idea of an "open future", which is not yet fixed, but remains to be determined by "decisions", in accordance with some process, while compatible with both Whitehead and quantum theory, is incompatible with the determinism of classical physics. Hence certain key features of the classical-physics implementation of relativity theory need to be altered in the passage to an open-future theory.

In the deterministic world of classical relativity theory one can label the actual space-time points in a variety of ways. In different labeling schemes the surfaces of "constant time" cut through the four-dimensional space-time continuum at different angles. Thus two space-time points that are "at the same time" according to one labeling convention will usually be at different times according to another convention. All of these labeling schemes are ontologically on a par.

But in classical physics there is no objective idea of “becoming” associated with these surfaces: the whole history of the universe is fixed, and hence the idea of a “coming into being”, or a “becoming”, is fundamentally illusory. Different observers who use different labeling conventions would have different *illusions* about which events are in “unison of becoming”, but because the whole idea of “becoming” is itself an illusion, there is no rational reason to transcribe *all* of these conflicting illusions about “unison in becoming” into realities in the passage to an open-future theory. Indeed, from the perspective of Relativistic Quantum Field Theory, Whitehead makes an actual mistake when he tries to elevate *all* of the conflicting classical-physics illusions about which occasions are in “unison in becoming” into ontological realities.

The natural ontology associated with relativistic quantum field theory was not really clarified until the works of Tomonaga and Schwinger in the 1940’s. In non-relativistic quantum theory, ontologically interpreted, there is an advancing constant-time surface that separates the fixed (already determined) past from the open (yet-to-be determined) future. By an “advancing” surface is meant a linear sequence of surfaces such that the region lying behind any surface lies also behind all subsequent surfaces. Tomonaga and Schwinger showed that the non-relativistic idea could be carried over to relativistic quantum field theory, with the constant-time surfaces of the non-relativistic theory generalized to “space-like surfaces”, which are surfaces that can be formed by continuous transformations of a constant-time surface that maintain the condition that every pair of different points on the surface are separated by a *space-like* displacement. The

Tomonaga-Schwinger construction shows how the proper generalization of the idea of “unison of becoming” is tied to a *single advancing space-like surface* along which potentialities are converted into actualities. This construction allows a coherent meaning to be given to Whitehead’s idea of “the expansion of the universe with respect to actual things.” (PR, p. 214).

Pauli once remarked to me that this Tomonaga-Schwinger idea of an advancing spacelike surface was not basically different from the nonrelativistic idea of an advancing constant-time surface. The Tomonaga-Schwinger idea of a single preferred advancing spacelike surface might appear to go against the intuitive flavor of relativity theory. But according to quantum thinking it is the *predictions of the theory* that must conform to the precepts of the theory, not the mathematical structure of a reality that lies *behind* the predictions. Tomonaga and Schwinger show that the predictions of quantum field theory will conform to the demands of the theory of relativity, even though all of the classically allowed surfaces of “unison in becoming” are not treated on an ontological par. Thus Whitehead’s attempt satisfy the requirements of the theory of relativity within an open future context by imposing *classically motivated* conditions tries to do something that seems ill-conceived, first, because it tries to apply in an essentially indeterministic setting conditions that owe their validity to determinism, and, second, tries to impose, by virtue of relativity, conditions that ontologically conceived relativistic quantum field theory does not satisfy..

Hättich examines this question of “the unison in becoming” in great detail. On the basis of Whitehead’s words themselves, he concludes that the demands of

rational coherence requires abandoning Whitehead's effort to ascribe "unison in becoming" to all of the different frames associated with different observers.

Dropping that unachievable demand, but retaining the rest, Hättich arrives at "a unique layer-cake structure" (p. 84), in which the successive "durations" sit on top of each other like the layers of a cake in four-dimensional space-time. Each layer is associated with a concrescence. The "Actual World" of each layer (i.e., the complete source of the input data for that layer) consists of *all* of the lower layers. But each whole new layer eventually separates into a discrete set of concrescing actual occasions that are "located in" disjoint spacetime regions.

It is probably significant that Whitehead seemed less than certain in his discussion of this idea of "unison in becoming" and "duration" (PR, p.125). He stressed that the complex idea about duration that he was proposing "is based upon scientific examination of our cosmic epoch, and not on any more general metaphysical principle". (PR. P. 125). But it now turns out that *his idea* of what scientific examination reveals is not concordant with what contemporary basic physics reveals: his idea was based too heavily on the illusions about becoming associated with *deterministic* classical physics.

Hättich notes (p.75) that similar conclusions about the causal structure were obtained by Stapp (1975, 1979) and by Nobo (1986). The approach of Stapp is based on the need to accommodate certain faster-than-light information transfers entailed by *certain generalizations* of the arguments of Einstein,

Podolsky, and Rosen (1935), and of John Bell (1964). Hättich confirms that the hidden-variable approach of Bell and his followers are too weak to establish the needed faster-than-light conclusion: one needs to go to the non-hidden-variable approach used by Stapp (1975, 1979, 2004, 2005)

Hättich's main conclusion (p. 249) is that Whitehead's doctrine of actual worlds is ruled out. But that conclusion does not follow from his arguments. The simplest way to rescue Whitehead's theory from the impact of Hättich's analysis is to postulate that: (1) The actual occasions form *an ordered sequence* --- i.e., that each of Hättich's layers consists of one single occasion---with the regions associated with the sequence of events/occasions separated by an advancing sequence of spacelike surfaces; (2) The actual world of any occasion consists of the already determined occasions that lie in its backward light cone; and (3) Whitehead's principle of the Objective Immortality of the actualized occasion be understood in the way suggested by his example (PR p. 43) of the Castle Rock at Edinburgh": when it shatters, the various the fragments are its *parts*, so that which parts are used in the construction of some later occasion influences which parts *remain available* for use in the construction of other later occasions. Thus the nonlocal (faster-than-the speed-light) features of quantum theory are explained by the fact that the choice in one region of which potentialities emanating from a prior occasion are chosen to be used in this region influences the content of the set of potentialities *that remain*, and hence are available for use in another region. This is the way the subtle faster-than-light effects are

generated in (relativistic) quantum field theory---in a way concordant with Whitehead's doctrine of actual worlds.

Hättich's book is valuable because it presents Whitehead's ideas, or at least one view of Whitehead's ideas, in a *detailed linear way* that meshes with the ideas of contemporary relativistic physics. From the perspective of quantum theory it provides a possible foundation for passing from the established pragmatic framework to a broader non-anthropocentric cosmological theory. From the perspective of Process Philosophy it gives a different slant on what conditions are really imposed by compatibility with Einstein's theory of relativity..

References.

Bell, J. S. (1964): "On the Einstein Podolsky Rosen Paradox". *Physics* **1**, 195-200. Reprinted in (Bell, 1987, pp. 14-21).

Bell, J. S. (1987): *Speakable and Unspeakable in Quantum Mechanics*.
Cambridge: Cambridge University Press.

Einstein, A, B. Podolsky, and N. Rosen (1935): "Can Quantum Mechanical Description of Physical Reality be Considered Complete?". *Phys. Rev.***47**, 777-780.

Haag, R. (1996): *Local Quantum Physics*. 2nd Edition. Berlin: Springer.

Nobo, J (1986): *Whitehead's Metaphysics of Extension and Solidarity*. Albany: SUNY Press.

Shimony, A. (1993): *Natural Science and Metaphysics*. Volume 2 of *Search for a Naturalistic World View*. Cambridge: Cambridge University Press.

Stapp, H. P. (1975): "Bell's Theorem and World Process". *Nuovo Cimento* **29**, 270-276.

Stapp, H. P. (1979): "Whiteheadian Approach to Quantum Theory and Generalized Bell's Theorem". *Found. Phys.* **9**, 1-25.

Stapp, H. P. (2004): "Bell's Theorem Without Hidden Variables". *Amer. J. Phys.* **72**, 30-33. (Also at <http://www-physics.lbl.gov/~stapp/stappfiles.html>)

Stapp, H. P. (2005): "Comments on Shimony's Analysis" To be published in *Found. Phys.*, In the Asher Peres Festschrift.